Pore Fluids and Introduced Materials in the Heated-Rock Environment at Yucca Mountain, Nevada

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We collect water samples from packed-off regions of boreholes in an underground heating test at Yucca Mountain to investigate water movement and the effects of heating on tuff pore-fluid compositions. The majority of water samples are very dilute and are predominantly steam that condensed in the sampling lines. A few samples with up to ~80 ppm Cl may contain rock-pore fluids. Suites of water samples with distinctive compositions were collected from packed-off intervals in two boreholes. These generally low-pH samples contained large amounts of Cl (up to 1,250 ppm) and SO_4 (up to 821 ppm), plus detectable Cr, Mn, Ni, and Zn. The neoprene (polychloroprene) packers were considered possible sources of fluid modification because they contain both Cl and S. Steel components of the packers are possible sources of the transition metals.

Two types of heating tests were performed on neoprene and tuff samples. In the flow-through test, air was circulated through test cells with ground samples of neoprene or tuff or through an empty test cell at 190, 130, and 90ºC. The air was then bubbled through water to extract soluble volatile species. Water samples associated with neoprene contained elevated chloride (up to 18,791 ppm) and sulfate (up to 155 ppm), and had lower pH than samples from the other test cells. More acidic and higher chloride samples were collected from neoprene at higher temperature. In follow-up tests at lower temperatures, detectable lowering of pH due to neoprene degradation was noted at temperatures as low as 59ºC, with a pronounced pH effect at 71ºC.

Boiling-water tests contacted tuff or neoprene directly with boiling water for eight days. The pH of water with tuff was buffered by tuff-gas reactions. For water with neoprene, the pH was not strongly affected, yet chloride (up to 339 ppm) and sulfate (up to 55 ppm) were produced.

In the flow-through test, oxygen was readily available, resulting in the generation of HCl from the oxidized neoprene. In the boiling test, the oxygen concentration was insufficient for much oxidation of neoprene to occur. The tests show that generation of Cl-rich low pH waters may occur in borehole intervals at sub-boiling and near-boiling temperatures with temperature gradients within the packed intervals.